US-ATLAS June 2002

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Physics activities

- Update since last November
- Short term project activities – mainly DC1
- Physics activities in US.
- Appendix – Project scope and structure

Update Since last review

- Physics support person hired
  Giorgos Stavropoulos hired by UC Berkeley on NSF funds in May 2002.
- DC0 completed (as least my part).
- All tools in place for DC1 phase 1.
- HepMC has appeared in CLHEP 1.8 (end of May), 21 months after they agreed to take over this atlas product.

Code status in atlas releases

Provided support for current versions of Herwig (6.4) Isajet (7.63) and Pythia (6.203). All updated since November.

Support for Tauola (initial work by Barcelona student). new since November

Support for special purpose MC's has begun (very late; lots of complaints from users about the delay). This should improve now Giorgios has arrived. May 2002

Rudimentary support for Phojet available next Release

LHC wide activities

An an hoc group (MC4LHC) has started up. Meetings in March and May 2002. Approx 10 people from CMS, ATLAS, LHCb and CERN theory. Expect to bring in more people. Two separate but related goals.

- Physics modeling and tuning. Experimenters and theorists. Improve modeling of LHC physics and agree on common simulation issues (min bias etc) so physics studies can be compared. Some work has begun (Used in DC1). Workshop at CERN summer 2003

- Common support issues. Pool resources on support issues where possible. An RTAG on this has been approved by LCG. Committee is being set up to set requirements and propose scope. Among the issues are common support and CLHEP.

Short term Goals & Deliverables

Data Challenges

Current round of Data Challenges began in October 2001.

DC0 Small physics samples (10^5) $Z + jet$ events passes through full chain. Event Generation complete March 8 2002 using all three primary physics generators.

DC1 Two phases.

Phase 1 uses G3 and is aimed at data needed for HLT TDR. Generation and simulation has begun with the biggest sample (10^7 jet events). Other samples will follow. Reconstruction is expected to begin in September (using new Event Model). Some Event Filtering tools incomplete.

Phase 2 (October 2002) will use both G3 and G4 and a large number of "Physics" samples will be made. Used to test distributed Analysis model and Grid tools. Real issue here is contributions of US Atlas physicists. There will be another atlas physics meeting to assess the results of DC1 phase 2.

Responsible for setting and validating of parameter sets and Q& A on Generation. (European is running the Q& A)

Note change in persistancy technology between DC0 and DC1.

Non-DC short term issues

Evaluate CLHEP version of HepMC and migrate the atlas code to use this version.

Herwig interface is very hard to use (mainly due to poor design of Herwig). Will rewrite it using the Python scripting feature of Athena to allow user dialog at run time and demonstrate utility of scripting interface. Improve efficiency for some processes.

Respond to users and provide full support for specialized event generators – Essential for DC1 phase 2.

Integrate Isajet and Herwig with Tauola (should be default for DC1 phase 2)

Interface to G4 and management of MCTruth (RTAG???)

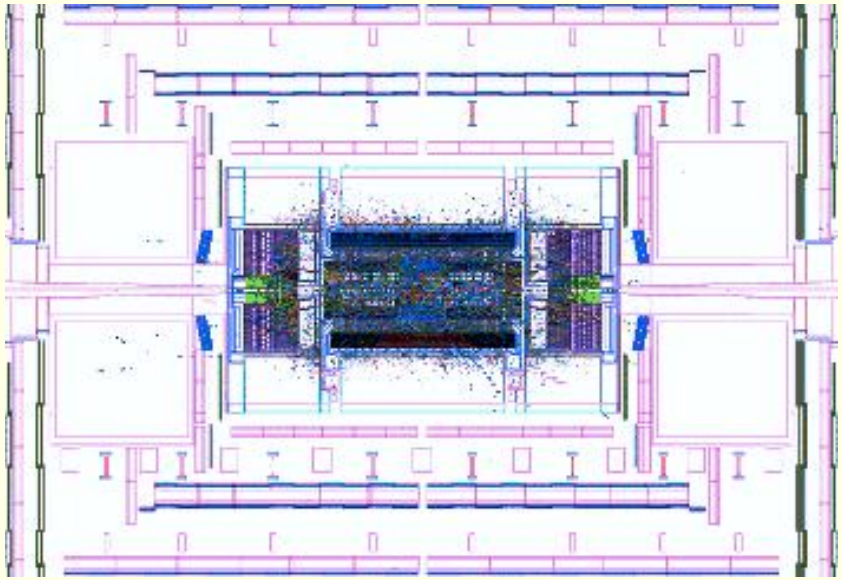
Integrate EvtGen – Dedicated B decay package, vital for B-physics group (Trying to persuade them to do it)

Physics studies

US work on SUSY, Extra dimensions, Top quarks, W couplings

Physics Coordination now has 5 US members (Dobbs, Hinchliffe, Paige, Parsons, Shupe, out of 25 total)

Helio Takai (BNL) is leading task force on Heavy Ion physics in ATLAS. Letter of intent sent to DOE in March 2002: proposal next year. On agenda for LHCC June 28. Meeting on Sunday in Clarement-Ferrand. Work focused on Calorimetry and muons (Si occupancy is 35% in first layer)

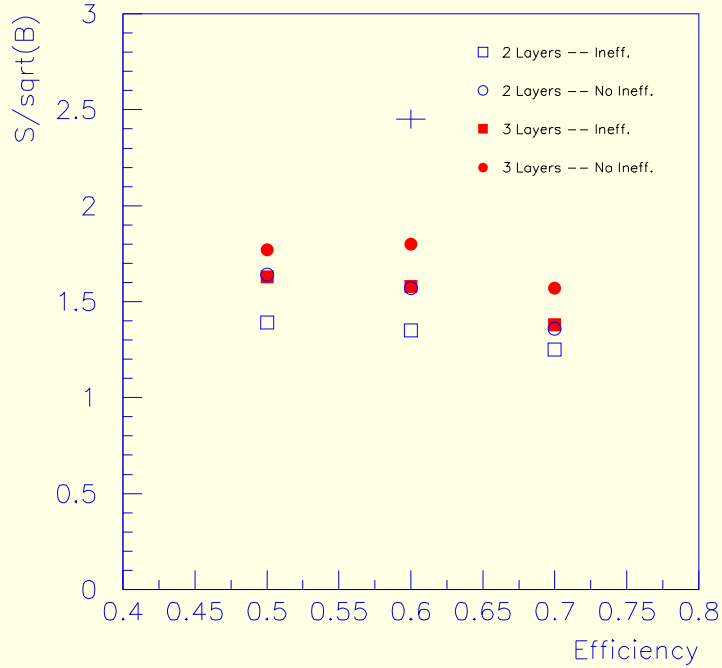


Detector Example –Pixel Staging

Middle layer of Pixel Barrel may be delayed/staged due to funding shortfall. Work to assess possible physics loss (D. Costanzo)

ttH final state may be useable to observe $H \longrightarrow b\bar{b}$ and measure couplings. Signal is marginal with baseline detecotor

May be hopeless with one missing layer



Upgrade Studies

Physics studies carried out in Summer 2000 and 2001 in response to request from CERN management.

Joint studies with CMS (plus theorists in 2001).

Completed and published as hep-ph/0204087 (Joint study) hep-ex/020319, J.Phys G (ATLAS only). 3 US-atlas authors.

Addressed physics impact of Luminosity and energy upgrades. $28\mathrm{TeV}$ and 10 times design luminosity.

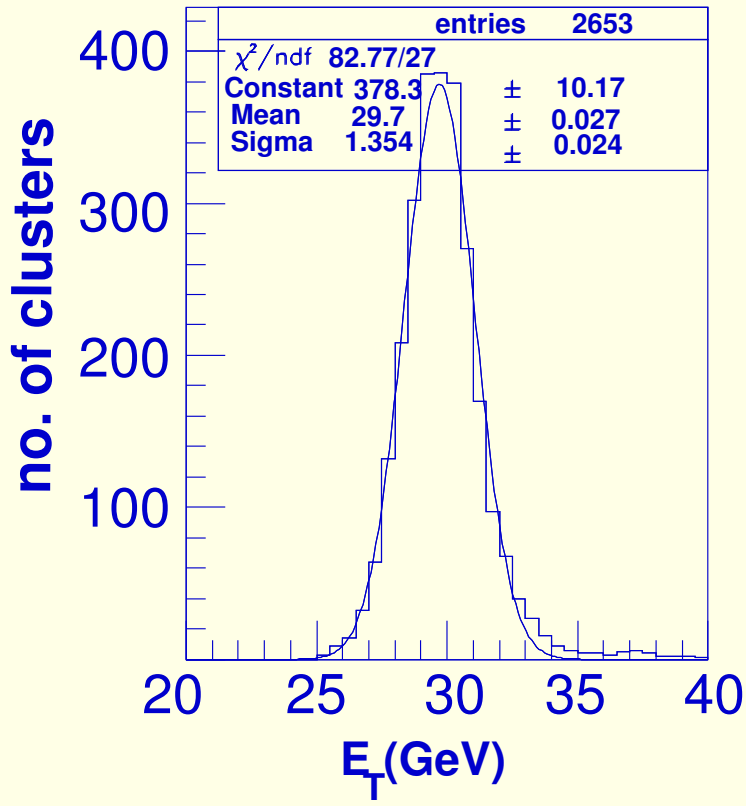
Most activity focused on luminosity upgrade as this is less demanding for the machine and less costly

Ultimate Luminosity of 2.3×10^{34} could be achieved by current design but only in two experiments (ATLAS+CMS)

Detector Performance

Luminosity is much more demanding

LAr calorimeter performance degrades
30 GeV electrons $\frac{\sigma}{E} \sim 2.5\%$ at 10^{34}
$\rightarrow \frac{\sigma}{E} \sim 3.6\%$ at 10^{35}



b-tagging

Rejection factors against u-jets
for 50% b-tagging efficiency

$P_T(\mathrm{GeV})$	10^{34}	10^{35}
25-40	33	3.7
45-60	140	23
60-100	190	27
100-200	300	113
200-350	90	42

e/jet separation: $40\mathrm{GeV}$ E_T

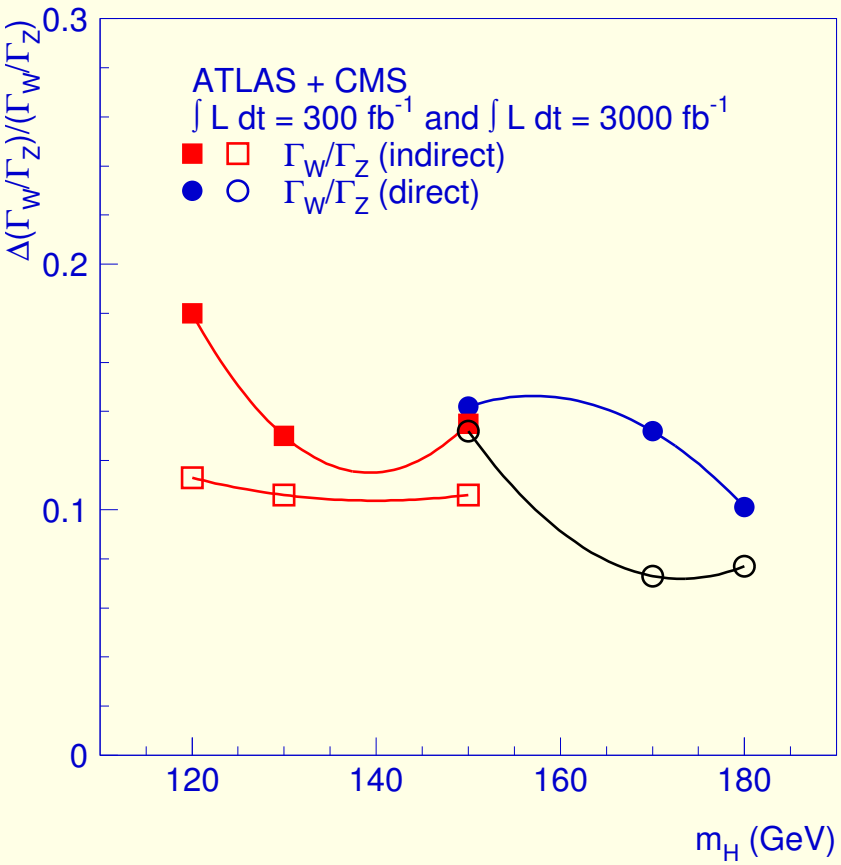
	Electron effic.	Jet Rejection
10^{34}	81%	10600 ± 2200
10^{35}	78%	6800 ± 1130

Measurements of Higgs Couplings

Luminosity upgrade improves precision by up to a factor of two

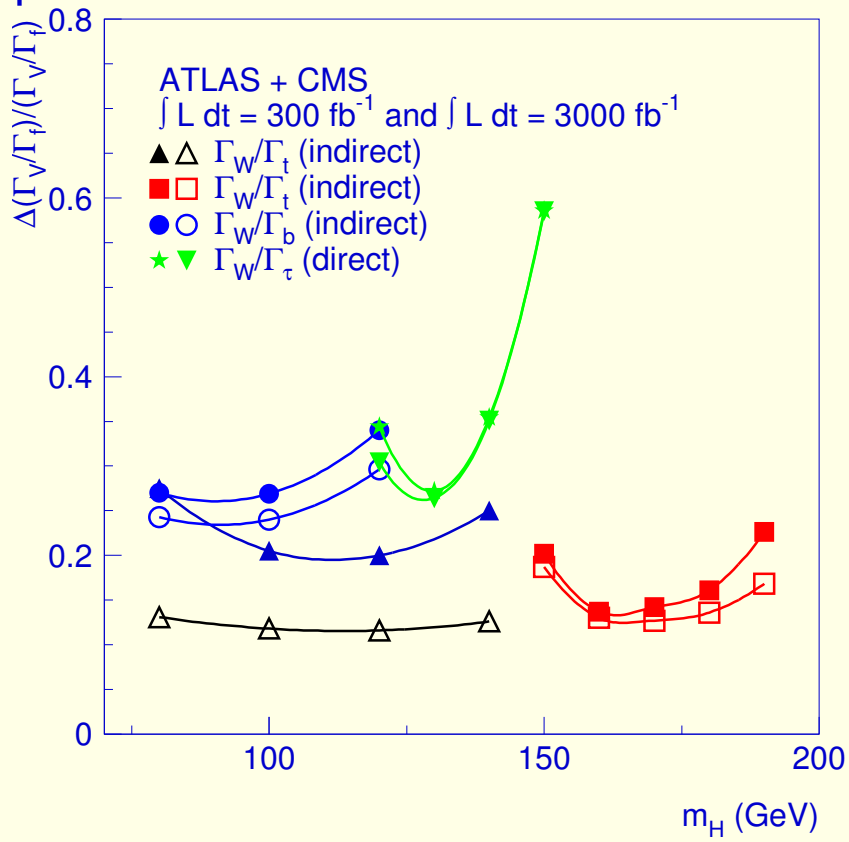
Boson couplings

Measured from $\gamma\gamma$ WW and ZZ decays



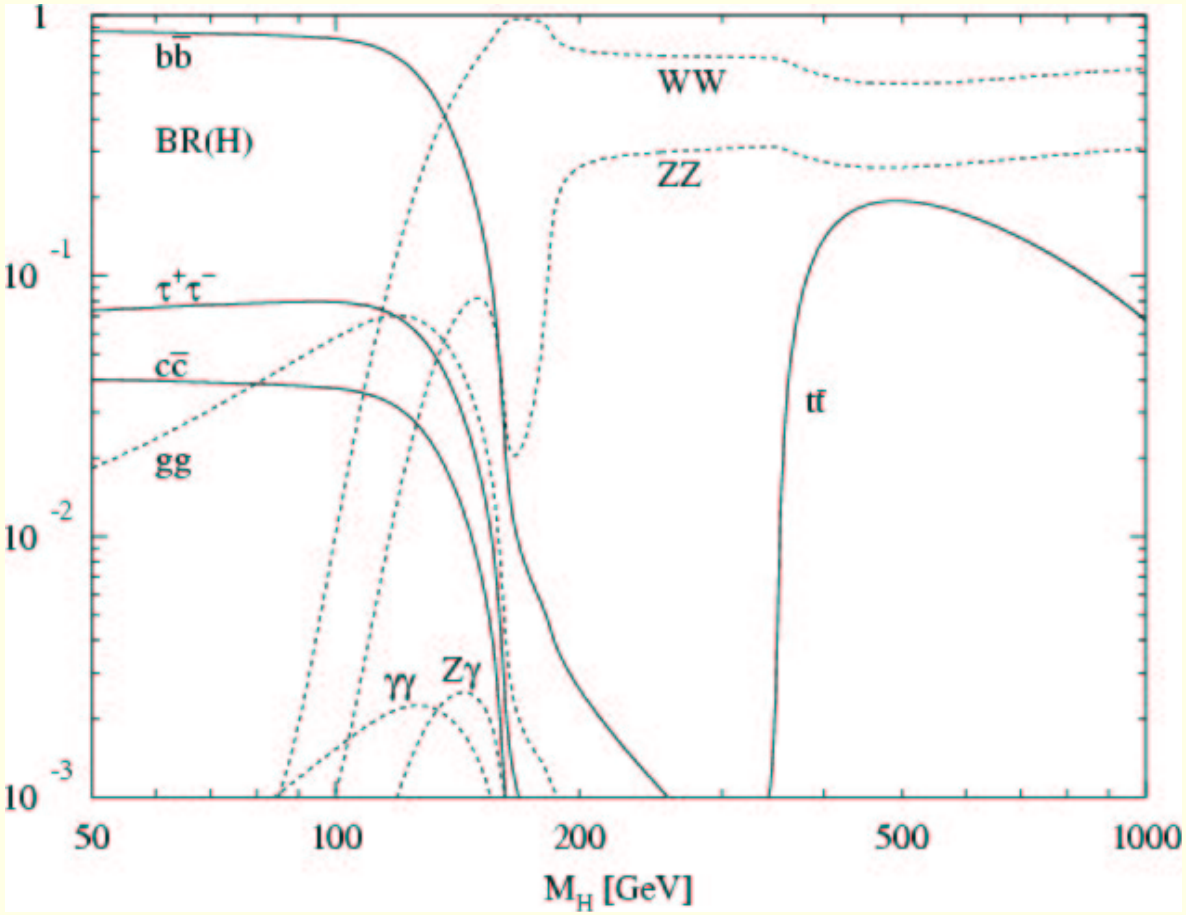
Fermion couplings

Inferred from $\gamma\gamma$ and WW final states and comparison of WH, $t\bar{t}H$ and H production



$H \to Z\gamma$ is with $Z \to \mu\mu$ or $Z \to e^+e^-$ is visible

BR



ATLAS+CMS 600fb^{-1} 3σ; 6000fb^{-1} 11σ

Higgs self coupling??

Preliminary particle level study of HH final states which contains a contribution from λ_{HHH} Very hard to measure anywhere: linear collider folks claim 20% precision.

Event rates for $6000\mathrm{fb}^{-1}$, both total rates and rates from WW fusion studied

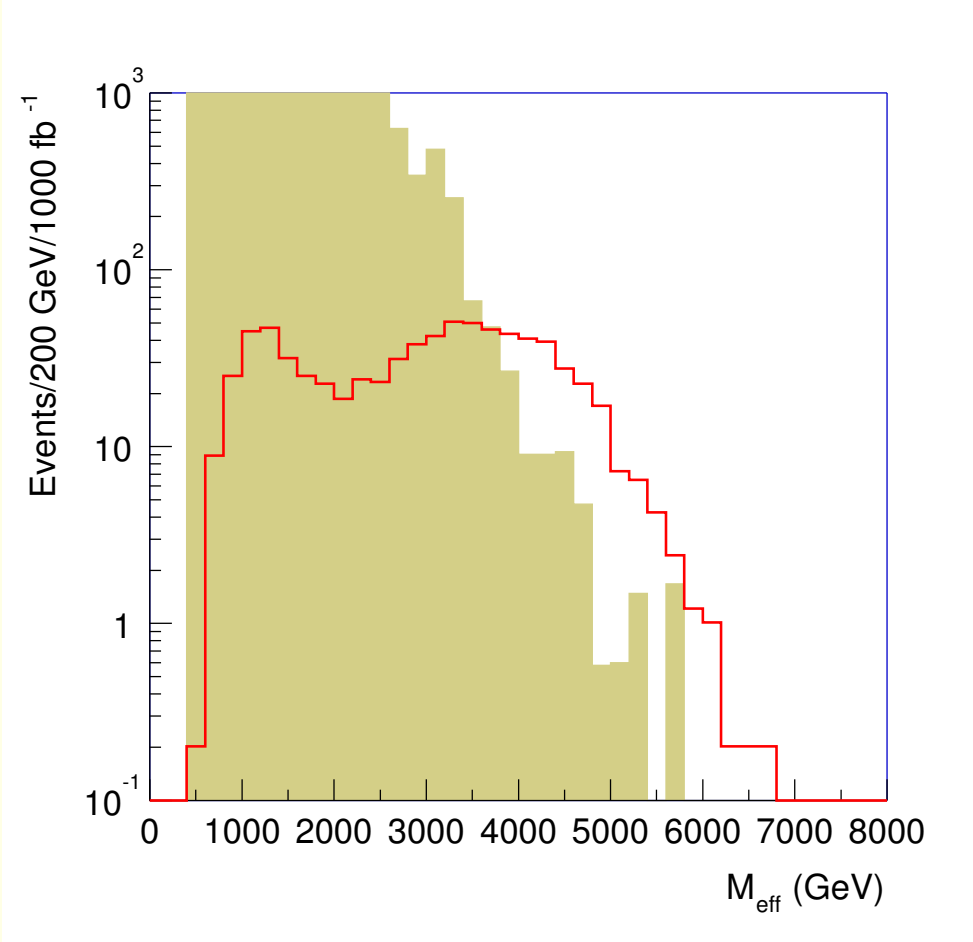
Process	$M_H = 120$	$M_H = 140$	$M_H = 170$
$HH \to 4b$	6000	1000	0.5
$HH \to 2b\ell\nu\ell\nu$	500	650	5
$HH \to 4\ell 4\nu$	10	90	235
$qqHH \to qq4b$	380	70	0
$qqHH \to qq4b$	30	40	1
$qqHH \to qq4b$	0.5	6	15
$t\bar{t}H \to 6b\ell\nu jj$	15	2	0

b-tagging efficiency is vital (50% assumed)

Only a few backgrounds estimated: jet rejection at least 40 is needed

SUSY

$M_{\tilde{g}} = 2.4TeV$
SM is shaded



Mass reach extends by 30% to $3.5\mathrm{TeV}$ for gluinos in case of luminosity upgrade More detailed measurements become possible Note that energy upgrade is more powerful

Appendix –Project activities – Reminder

Organization

Goal is to integrate Generators so that

All generators present data in the same format to simulation

Parameters are set at runtime

Version switching must be possible

Actual Generators are maintained outside Atlas codebase

Interface packages are part of Athena

See WBS for complete structure

External packages

Each generator exists as an external package
/afs/cern.ch/atlas/offline/external/
allows us to have version control

Linksets from External for ease of use

Pythia 6.129, 6.157 and 6.203 Exist – Maintained by Stan Thompson

Pythia 7 Maintained by Maya Stavrianakou

Herwig 6.1 and 6.4 Exists – Maintained by I.H. (volunteer needed)

Isajet 7.44 - 7.63 Exist – Maintained by Jim Shank

Taoula/Photos vanilla/CLEO/ALEPH versions Exist – Maintained by I.H. (volunteer needed)

Stdhep 4.07 Maintained by I.H. (volunteer needed)

EvtGen – Maintained by Maria Smizarska

Phojet – Maintained by I.H. (volunteer needed)

Others need to be there, in particular CompHep, Grace, MADGRAPH, vecbos

These tasks should be spread among many people

Athena Interface

Intererfaces to load events into common format (HepMC) that can be used downstream

Documentation in Generators/GeneratorModules/doc and
http://www-theory.lbl.gov/~ianh/monte/Generators/

Information is presented as a collection of HepMC structures

HepMC is an ATLAS developed product, exported to CLHEP

One interface per Generator. Interfaces are my responsibility at present

Conclusions

Just about managed to "stay above water"

Manpower shortage for DC.

Hired support person supported by project

Need to negotiate software agreement.

Hope that LHC wide coordination will yield long term savings.